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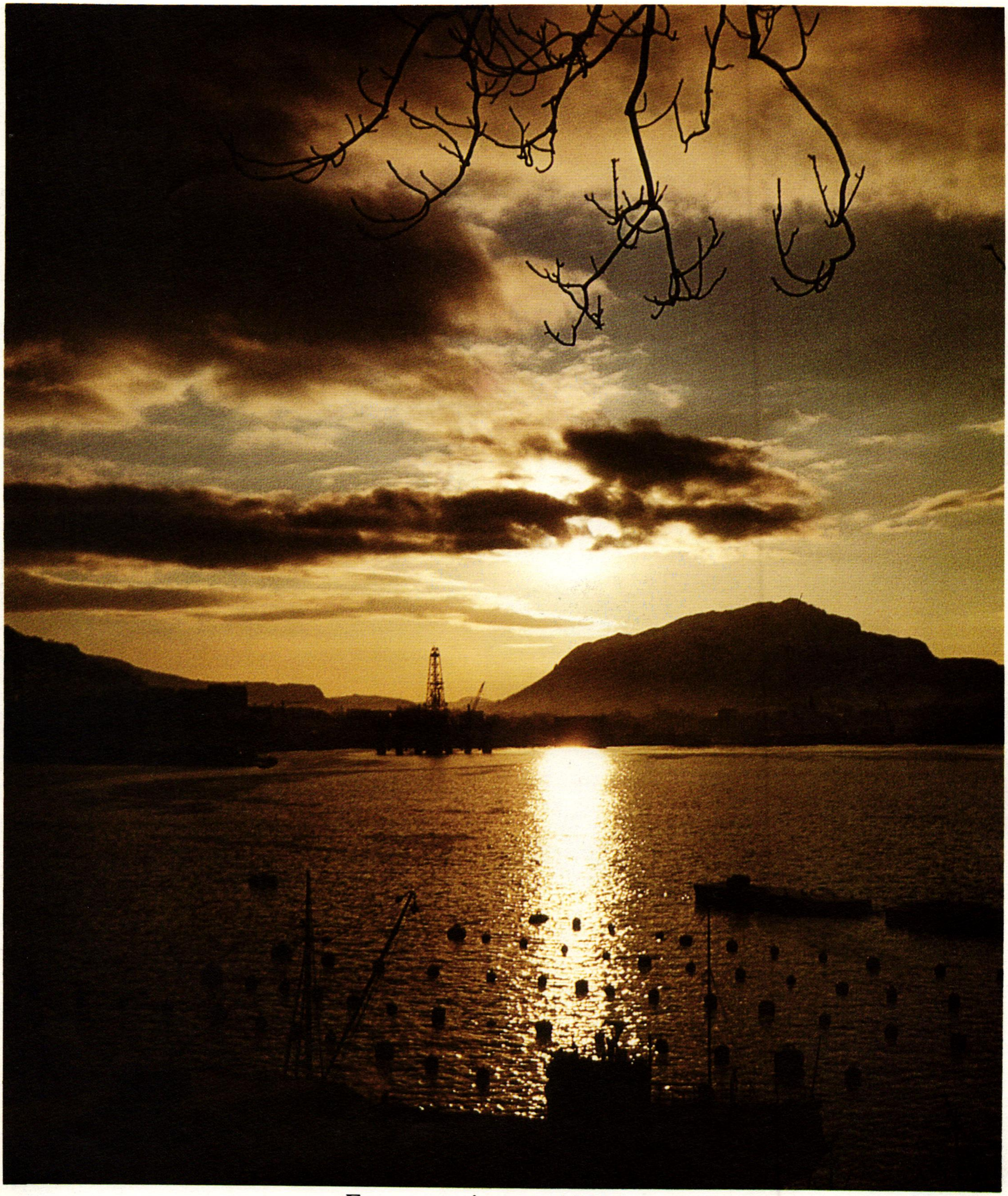

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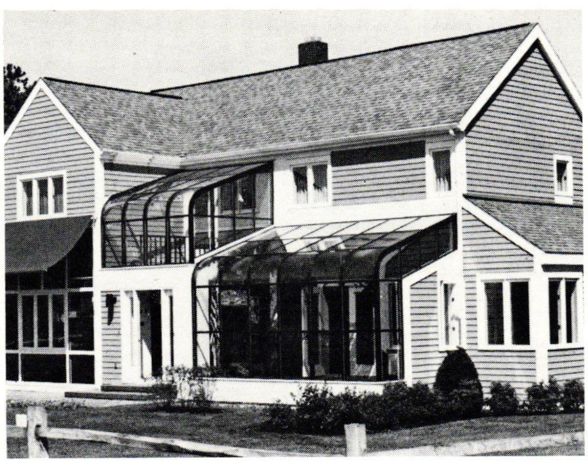

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by winter mid-day sun
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Introduction To The Special Energy Issues

By David Evan Glasser, Chairman
Department of Architecture
University of Wisconsin/Milwaukee

I was extremely pleased to be asked to take charge of this issue of the **Wisconsin Architect.** Over the past several years the growth of interest and activity in energy-related aspects of the architectural profession has been extraordinary. Special workshops sopnsored by the AIA, the Masonry Institute and others have attracted substantial, continuing interest of both students and practitioners. Our Department has experienced a corresponding increase in student concern for building conservation and passive design issues over the past few years. Preparing articles for this special issue has afforded the faculty the opportunity to take stock of and evaluate its efforts with respect to departmental support for studies dealing with Energy in Buildings. It is a matter of pride to the Department and myself to report that the School has committed itself to a surprisingly broad range of activities including coursework, studios, research, extension courses and community based seminar-workshops.

Aside from the benefits of the high visibility that our Department is beginning to earn by virtue of the vigorous activities, our student body is rapidly coming to understand that energy considerations in buildings are as basic to architectural design as circulation or spatial organization. This subtle transformation in the focus of student values and perceptions is particularly encouraging, from my standpoint. One of the most important commitments which our faculty makes is to the development of a strong set of social values which our students may bring to their professional responsibilities. The appropriate use of technology, concern for conservation of dwindling global energy resources and optimization of solar energy all are salient aspects of these social concerns. Our students' appetite for learning and utilizing these skills is not only delightful from our standpoint as educators, but should be instructive to the professionals reading this issue. They may reasonably expect to employ young architects-in-training with the skills and purposeful determination to transform and improve architectural practice in our region.

It is my hope that this will be only the first of many opportunities to share ideas and information with the Wisconsin professional community. The brief seminar held at the recent WSA convention in Milwaukee was instructive insofar as some mutual misperceptions were revealed and, I hope, resolved. It is the intention of the Department and myself to make an increasing effort to develop useful connections to the professional community. Among these efforts, in the Fall, we will be visiting chapters throughout Wisconsin in order to present some of our activities and to share thoughts about architectural education with practitioners from all parts of the State.

EDITOR'S NOTE

This issue of the **Wisconsin Architect** contains numerous articles prepared by members of the faculty of the School of Architecture and Urban Planning of the University of Wisconsin-Milwaukee. Energy continues to be one of the primary issues confronting our profession in the 80's. These faculty members have been kind enough to share their experience, research, and expertise in the articles that follow on matters pertaining to energy. The Editorial Board of the **Wisconsin Architect** is proud to present these very fine articles to the architectural community in Wisconsin. We trust that you will be as interested and informed by the content of these articles as we have been. A special thanks to David Evan Glasser, Chairman of the Department of Architecture at UW-M SARUP for his efforts in coordinating this most productive and informative undertaking.

WSA
Fall Design Workshop
September 17, 1982
La Crosse

Design
Interpretations:

Form
Function
Fantasy

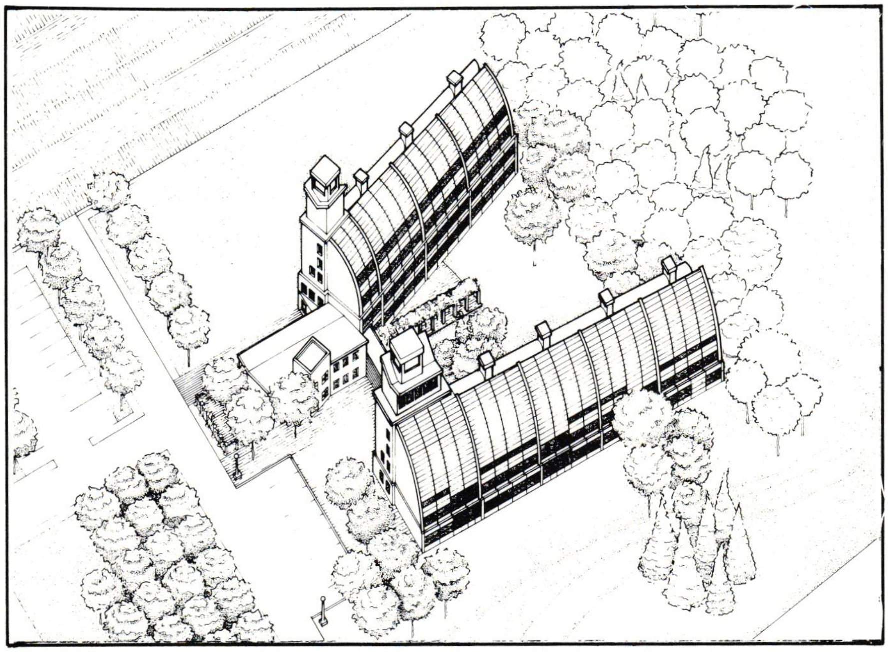
Studio Work In Energy Conscious Design

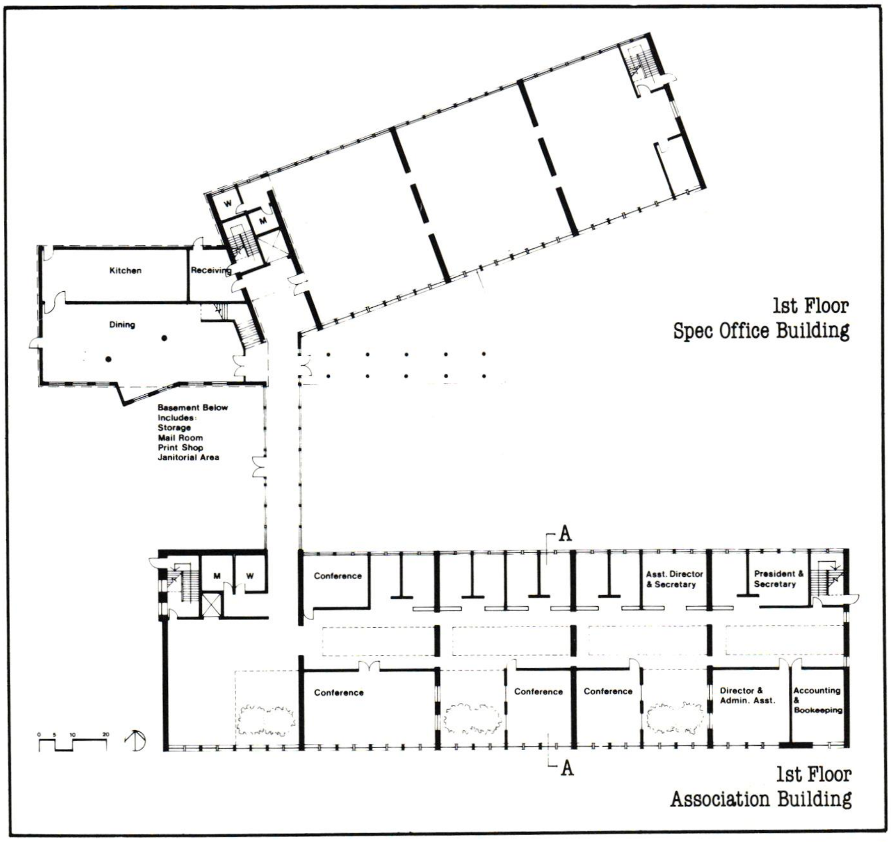
By Frederick A. Jules, Associate Professor

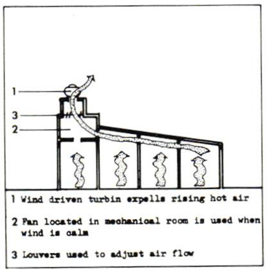
Energy conservation in design is a moral commitment to the future of our society and profession. Its importance need not be elaborated upon nor is it redundant to point out that historically it was only about 100 years ago that the nature of the built environment was profoundly affected by the development of automobiles, modern energy-wasting heating systems and unrealistically high heating and cooling standards. All schools of architecture have an obligation to address these issues to produce professionals capable of and committed to, meeting the problems associated with these issues through the design process. UWM has committed substantial portions of the curriculum to this objective: this report, however, concerns itself only with the studio dealing primarily with energy conscious architectural design.

The teaching approach employed in this studio may be simply outlined. Each semester typically includes two design projects dealing with two design principles. The first principle in design is placemaking without which conservation and social issues lack meaning. The second principle we seek to explore is passive design within a broad conceptual sense as well as with respect to specific building forms. This requires an understanding of the significance of urban form in energy conservation, the distinction between load dominated and skin dominated building programs, as well as building typologies and design strategies suggested by these differences.

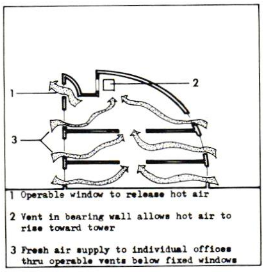
It does not suffice to simply appreciate these differences. In order to authenticate the design studio experience, real problems are employed, many in urban settings, in order to make the design challenge significant in relation to students' profes-



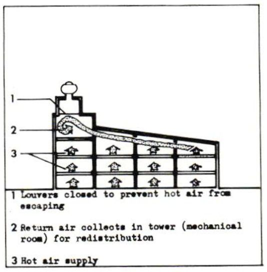




Summer Ventilation



Summer Ventilation



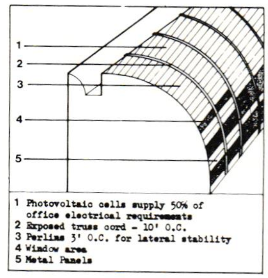
Winter Ventilation

sional development and to larger conceptual energy conserving strategies. Students are required to calculate derived energy savings as a means of verifying design proposals as well as identifying those variables critical to increased energy effective design which are then employed to modify preliminary proposals. Over the past 10 years, these calculation methods have been improving continually. We attempt to ensure that students are utilizing most current and accurate methods. For each project, students may be asked to calculate energy utilization several times as an integral part of an interactive design process emphasizing context, energy conservation and placemaking.

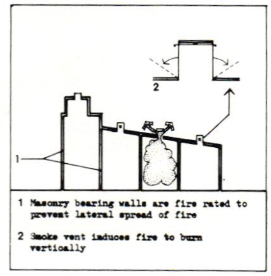
Our faculty is committed to this form of educational undertaking which will produce high quality professionals prepared to deal with design and energy conservation, within many varied contextual settings. The strategies employed in our energy conscious design studio offer students the opportunity for developing the methodologies essential for successful practice.

Selected portions of two projects are presented here as representative of student work in the aforementioned studio. The Association of Collegiate Schools of Architecture has sponsored Energy Conscious Design competitions for five years with support from D.O.E. and the Brick Institute of America. We have used these competitions as one of the projects in a semester every year they have been offered over which time our students have consistently won awards and had their work published. In last year's national competition, we received two cash prizes and were included in a publication of all the winners.

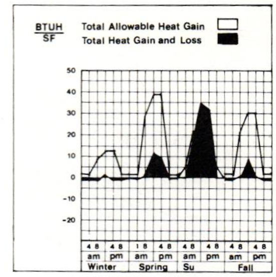
As of this writing, we have just been informed that this year our students won both first and second place in the open submission category in a field of 2000 entries screened down to 200 for the National jury. First place went to Jill Johnson and second place went to Matthew Tendler, both three year graduate students in our program.



Exterior Wall System



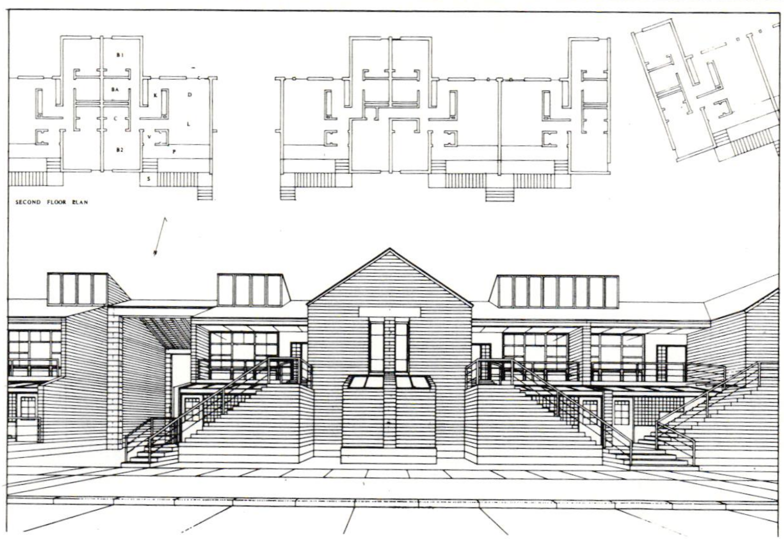
Smoke Ventilation

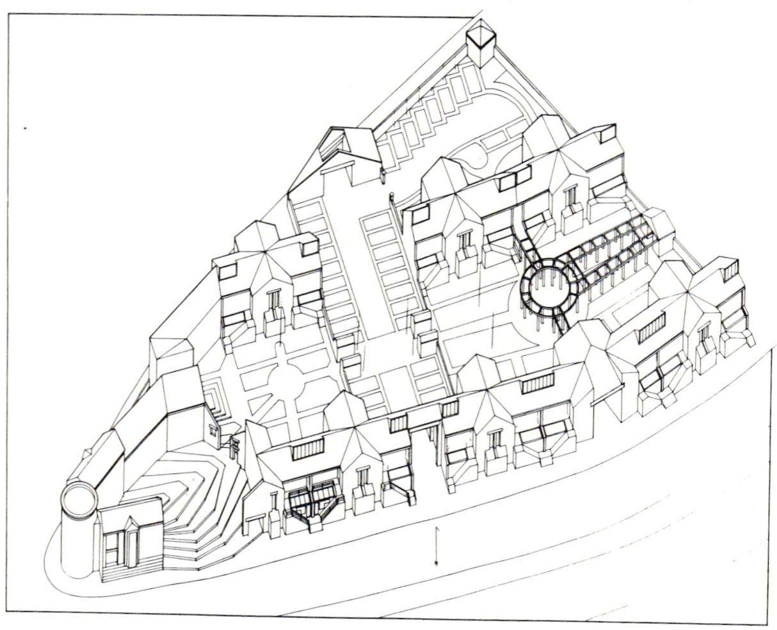


Spec Building
Heat Gain & Loss

The first project presented here is an entry to this year's ACSA competition by Rebecca James. It is for a prototypical suburban office building which is a load dominated building type. The solution combines strategies for daylighting, photovoltaics, ventilation and formal composition to form a memorable place to work.

The second project is a community service housing project for the Williamson Street neighborhood in Madison, WI. It was designed last year by James Shields. It is a skin-dominated building where orientation, density, urbanity and sense of place were admirably addressed.





Lessons From A Passive Solar Pioneer

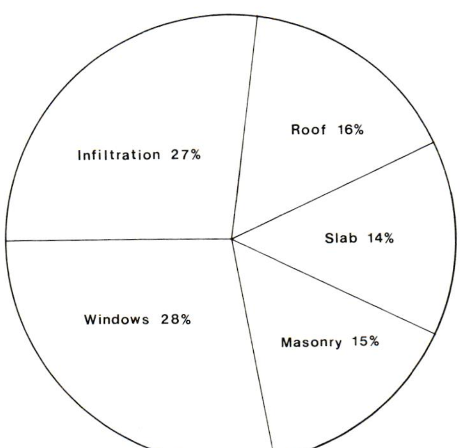
By Michael Utzinger,
Asst. Professor

Frank Lloyd Wright's Jacobs II house, designed in the 1940s, is widely recognized as a pioneering example of passive solar design. Wright called the house a solar hemicycle, as its curved form was believed to admit or reject sunlight according to the season. Many features appropriate to solar architecture are designed into this house. All living spaces have access to winter sunlight; the north wall is heavily bermed; masonry walls and concrete slab provide ample heat storage preventing overheating on sunny days; and a large overhang shades windows during summer. Unfortunately, the floor slab and roof are uninsulated, and south windows are single pane. During the 1980-81 winter, heating the home with fuel oil cost approximately $4,000.00. Energy consumption for heating is greater than 200,000 Btu per square foot of floor per year. Frank Wrights thermal design intentions notwithstanding, the house is an energy disaster.

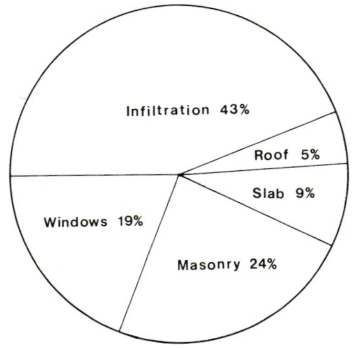
As a class project, students in the building energy analysis class were each asked to evaluate heat loss of the house as designed and to propose an energy retrofit. An important stipulation was that the visual image of the house could not be altered. The accompanying pie charts illustrate proportioning of heat loss between different skin components, for the house as designed and for the retrofit proposal illustrated at right. Heat loss is reduced nearly 50% by replacing single pane glass with thermopane; insulating the roof and upper four feet of buried masonry walls; removing the slab to provide insulation and to place piping for radiant heating within instead of under the slab. Infiltration remains a major problem as long as an air lock entry is not provided and the fireplace not closed off. Estimated energy consumption is half the amount measured during 1980-81.

In addition to evaluating heat loss through the skin, solar gains through the curved south window wall were examined. More than one third of the windows have azimuths greater than 36 degrees from south. The result is reduced solar gain during winter and some direct solar gain during summer. If the window wall was straight and faced south, solar gains from November through March would increase by 20%. While the curved plan reduces solar energy entering the house during winter, the form does protect the south wall from snow and rain. A protected outdoor microclimate is created which, during cold, sunny days, is much warmer than surrounding areas.

The Jacobs II house provides architects with a number of lessons. Energy conserving architecture involves two levels of concern, issues at the building form scale and issues at the construction detail scale. Students evaluated the Jacobs II house at only the detail level. Yet their details reduced fuel consumption by 50%. Attention to detail is a necessity of energy conscious design. Energy issues must also be solved at the design level. For example, infiltration could be reduced in the Jacobs II house with the addition of vestibule entries. In the last analysis, this project demonstrates that application of passive solar heating concepts without an understanding of total building energy flows can serve to abdicate the most well-intentioned solar design proposals.



House heat loss as designed $2800 \frac{Btu}{Hr\ °F}$



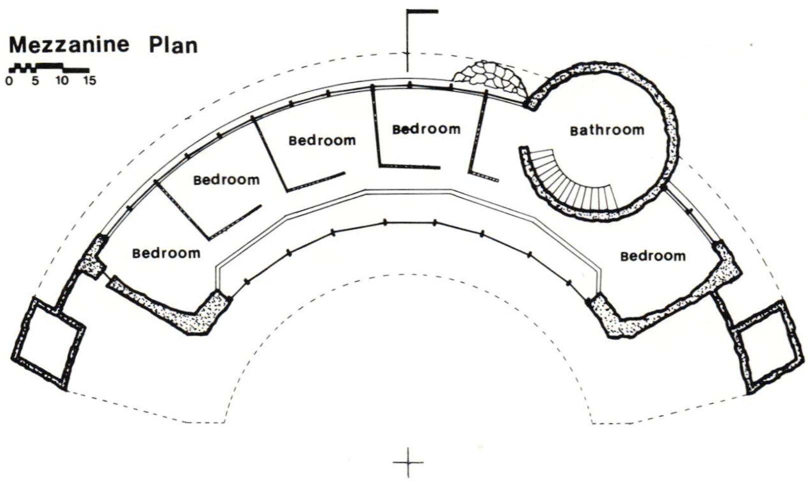
Redesigned heat loss $1500 \frac{Btu}{Hr\ °F}$

Acknowledgements David Havens and Loni Van Ryzin graciously provided energy use information for the Jacobs II house. Jerry Bruscato provided the illustrations.

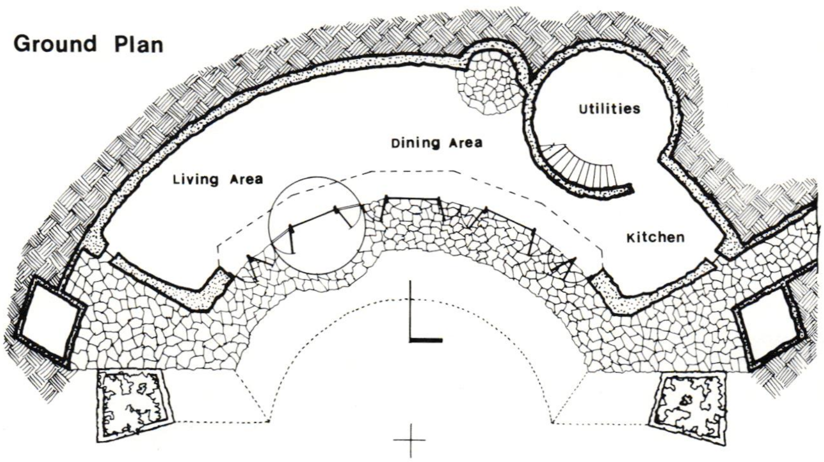
Jacobs II House

Middleton, Wisconsin 1948

Mezzanine Plan

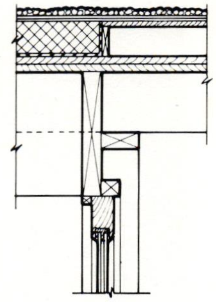


Ground Plan



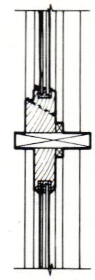
Insulation was added to the roof over living areas only.

A



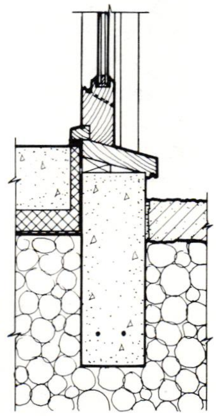
Single pane windows replaced with thermopane units including condensate channel at each sill.

B

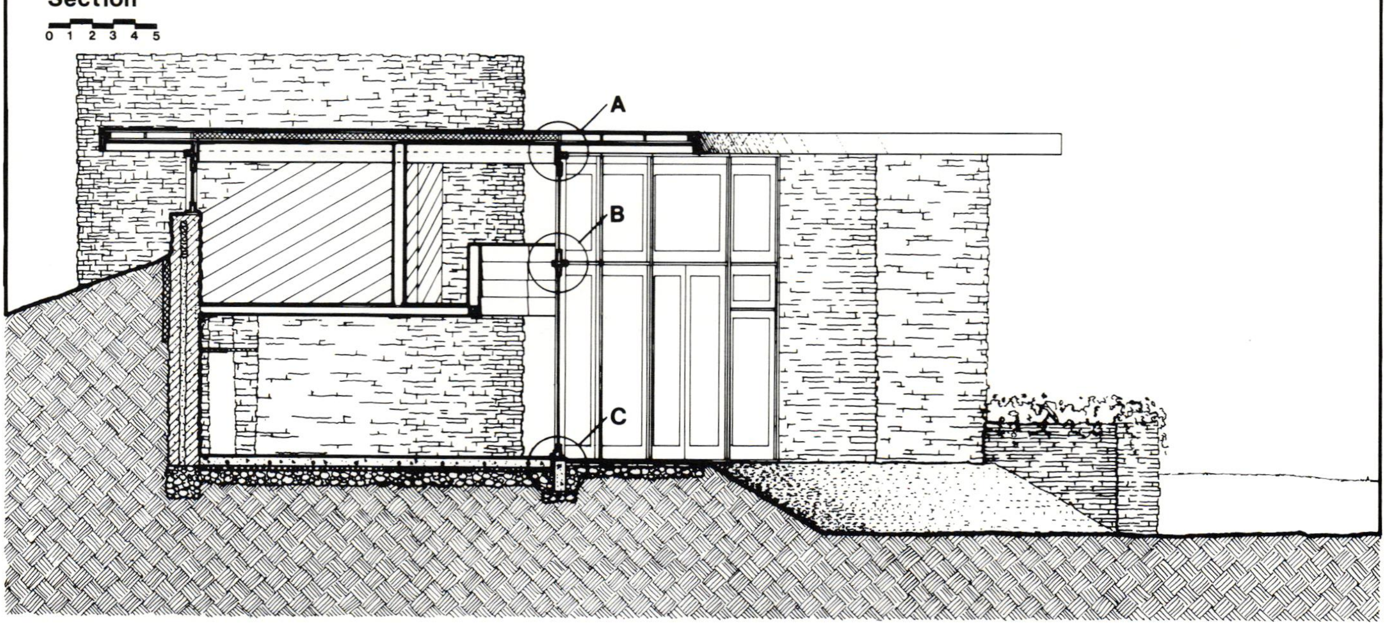


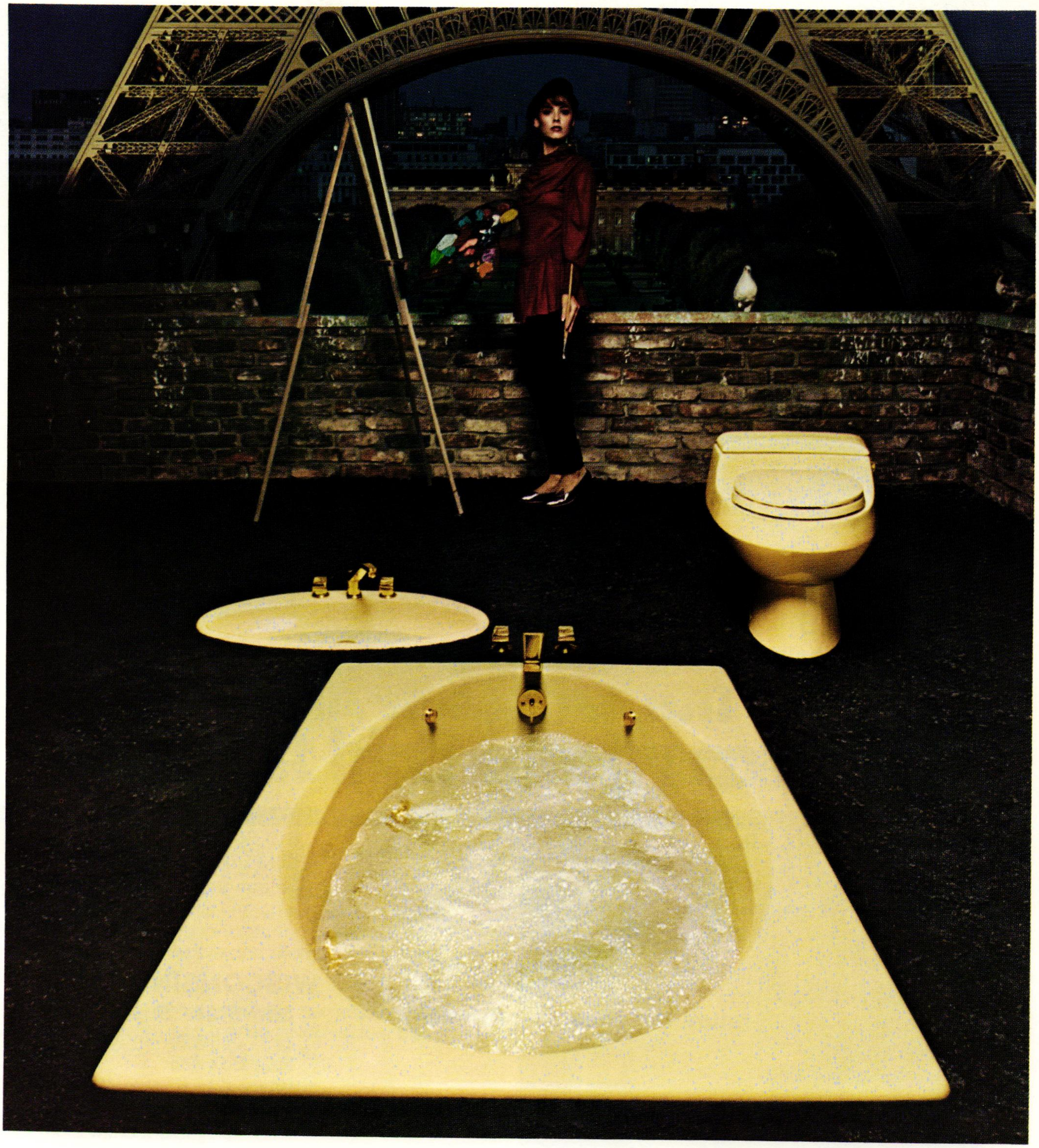
Floor slab originally extended under window, causing a thermal bridge. Redesign provides grade beam for the window and a thermal break between slab and outdoors.

C



Section





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This is a color that must be seen firsthand to be experienced. To view French Vanilla, as well as the full spectrum of bold Kohler colors and exciting Kohler products for the kitchen, bath, and powder room, check the Yellow Pages for the Kohler showroom near you.

THE BOLD LOOK
OF **KOHLER**

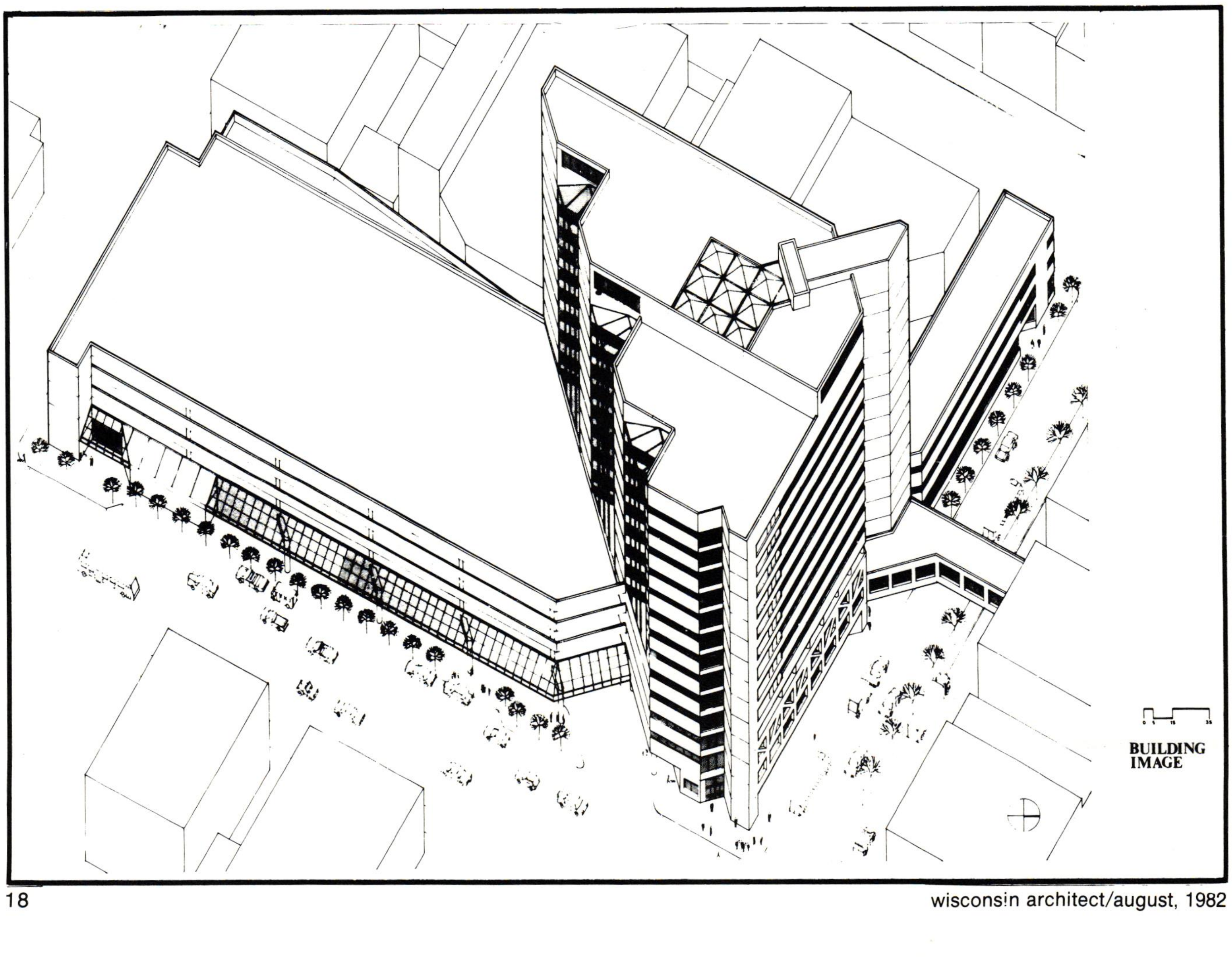
Green Bay Bus Terminal

By David Evan Glasser, Chairman
Associate Professor

In the Spring of 1980 I had the good fortune to manage a design studio which produced several remarkable results with respect to both architectural design and technology. The 699 design studio was a non-required course dealing with the integration of solar, structural, construction and environmental issues in relation to conceptual architectural design. The class consisted of a mix of senior undergraduates and graduate students with a variety of backgrounds. Students were given the option to work individually or in teams. The term length project discussed in this article was developed by a team of six students: Mark Helminiak, Steve Greiczek, Larry Tuttle, Jon Erdmann, Greg Baum and Doug Lasch.

The program for the building, which was developed with the Mayor's office of Green Bay, consisted of the following elements:

1. A multi-transit center incorporating 14-16 intercity buses, principally Greyhound, and as many as 26 local buses. The center was conceived as a depot and exchange point for city and intercity travellers.
2. Major waiting room with ancillary amenities. The development of a humane and serviceable environment was stressed.
3. Office space for City and State governmental offices - approx. 80,000 s.f.
4. Commercial office space of approx. 80,000 s.f.
5. Rentable commercial space for retail stores and service establishments.



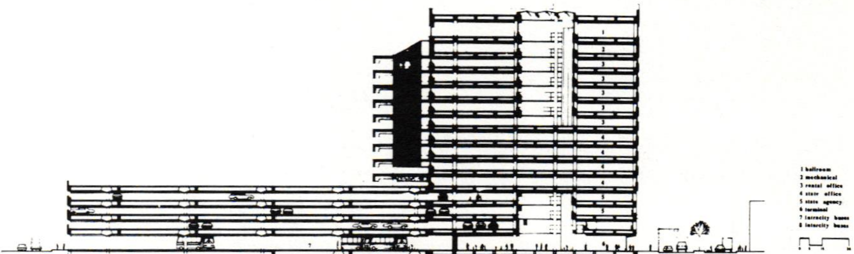
6. Skywalk connections to adjoining civic and commercial developments.

7. Thermal efficiency and use of passive solar techniques were emphasized.

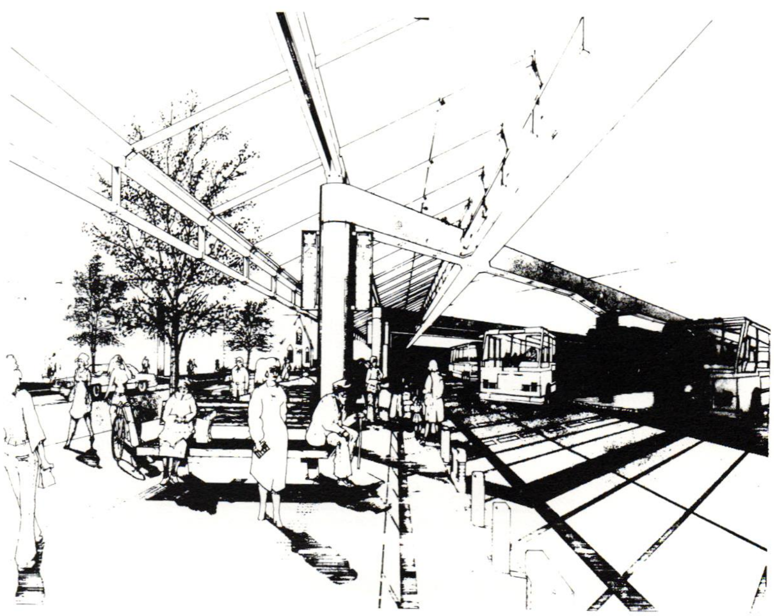
In addition to these points, it was determined beforehand that all projects were to be developed using precast concrete as the principal structural and architectural medium. Besides intensive readings and lectures on the subject, the class visited several major precasting plants in the region to develop a first hand understanding of the technology involved. The team whose work is illustrated here entered their project and gained third prize in the PCI international student competition.

The project is noteworthy from both an architectural and educational standpoint. First of all, the project is artistically distinguished, the more so for being a collaborative effort. Secondly, the well-researched understanding of both the solar and structural aspects are intrinsic to the design, rather than applied stylistic elements, as is often the case in student work. Most importantly, engineering work and computer analysis were undertaken to test the hypotheses incorporated in the project, resulting in a project beyond the realm of the typical student effort.

Thermal performance characteristics of this multi-use facility were assessed to be extremely favorable. The design incorporates three multi-level south-facing greenhouses generating high winter air temperatures which are collected by virtue of 'stack effect' distributed by fans within the floor system to north-facing portions of the structure. In addition, the thermal mass of the structure was such as to be able to function partially as a heat sink, permitting nighttime re-radiation into greenhouse spaces to maintain 55 F with outside air temperature at 0 F without supplementary heat.



SECTION LOOKING WEST



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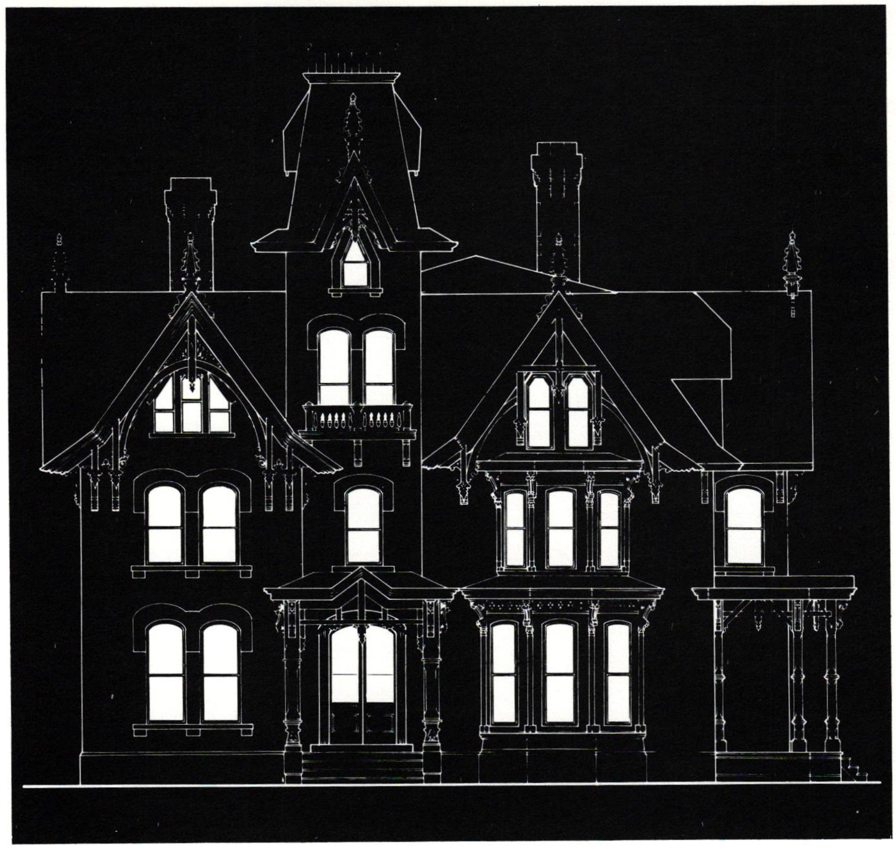
Some Thoughts On Building Conservation

By Douglas C. Ryhn
Associate Professor



Measured drawing of Day House, Wauwatosa, by Kirk Keller.

When one speaks today of energy consciousness in architecture, it seems only natural to speak as well of the conservation of older buildings. Anything built before World War II can be defined as an older building, but in terms of energy, another factor should be considered. Those older buildings were designed and constructed during a period when the cost of fossil fuel was high, relative to the general economy of the day. It was during those times, much as now, when architects, builders and owners had to be concerned about energy and therefore placed a great deal of emphasis on natural heat, light and ventilation.

Later, in the period from World War II up to the 1973 embargo, so-called cheap fuel bolstered the drive for lightness, transparency and flexibility, giving buildings of that era their distinctive character. The fact that they were not energy efficient, with some notable exceptions here in the midwest, was of little importance. Instead, emphasis was placed on the high technology that would produce the new images faster. In the process, architects experimented with innovative strategies such as glass towers with no apparent reference to orientation and windowless classrooms designed to hold students' attention. All in all, it was a free wheeling, no holds barred period of architectural development, when technological potentialities obscured many time-tested construction strategies, producing a vast stock of buildings with future historians will be hard pressed to evaluate.

Today's new buildings, of course, will have to respond to high fuel costs, either by design or by law. It is therefore really older buildings to which attention should be directed.

What are some of the energy attributes associated with older buildings? Of major significance, because it can be readily quantified in terms of dollars or gallons of fuel or BTU's is embodied energy. It was no surprise that a recent poster stressing historic preservation depicted an older (late 19th century) building as a fuel container.

Embodied energy is generally thought of as energy already invested in materials or construction. It ranges, for example, from the fuel burned to run the huge shovels that mine bauxite and the trucks and ships that transport the ore to processing plants to the electricity required to reduce the bauxite first to alumina, then aluminum, to the power needed to fabricate and anodize the building components and, finally, to the fuel needed on site to run the equipment that will place the components on the building.

This scenario of taking raw materials through processing into building materials and then into construction is repeated for practically every material ever used in building. Clay becomes brick and tile, limestone becomes cement, iron ore becomes steel, and yes, even with renewable materials, trees become lumber and plywood. When one becomes accustomed to looking at materials in this fashion, it is obvious that older buildings represent not only something of historic or architectural significance, but also a valuable resource rich in embodied energy.

The customary technique used to measure embodied energy is to compare the weight or volume of a particular material with an equivalent amount of fuel such as gallons of gasoline or the heat-producing equivalent in BTU's. Following are some interesting examples taken from **New Energy from Old Buildings,** National Trust for Historic Preservation, 1981. One should probably begin with a simple yardstick; the energy embodied in 8 carefully laid bricks in the wall of an older building is equal to the energy in one gallon of gasoline or about 125,000 BTU's. An example on quite a different scale is that of a 5 ton steel girder, which requires the expenditure of 257 million BTU's for processing and fabricating, plus an additional 13 million BTU's for transportation and erection, all adding up to a grand total of 270 million BTU's or slightly over 2000 gallons of gasoline! Some other examples which help further the point include these: it requires 450,000 BTU's to produce one gallon of paint, it takes 96,000 BTU's to produce a cubic foot of concrete, about the same for a cubic foot of stone, and about 9,000 BTU's to produce a board foot of lumber. No material is immune from conversion costs in terms of dollars and/or energy, and it follows therefore that conservation of older buildings through historic preservation or adaptive reuse is a prudent consideration.

Other important attributes of older buildings are the architectural elements and details which were developed to respond specifically to controlling the natural environment. Architects and builders have always dealt with the sun, both to capture heat and light and equally important, to exclude them. In the process, an incredible array of porches, clerestory windows, covered walkways and courts evolved as intrinsic parts of the vocabulary of older buildings. As if that were not enough, deep-set windows in heavy thermal mass walls often provided some degree of overhead shading to the south and side shading to the east and west. To these details add window shutters, vestibules, and cupolas, and one can quickly recognize the rich legacy awaiting anyone fortunate enough to find a handsome older building available for historic preservation or adaptive reuse.

Building conservation then **is** energy conservation with all the myriad additional benefits thrown in, preservation of architectural treasures, enrichment of cultural heritage and continuity of the historical thread.

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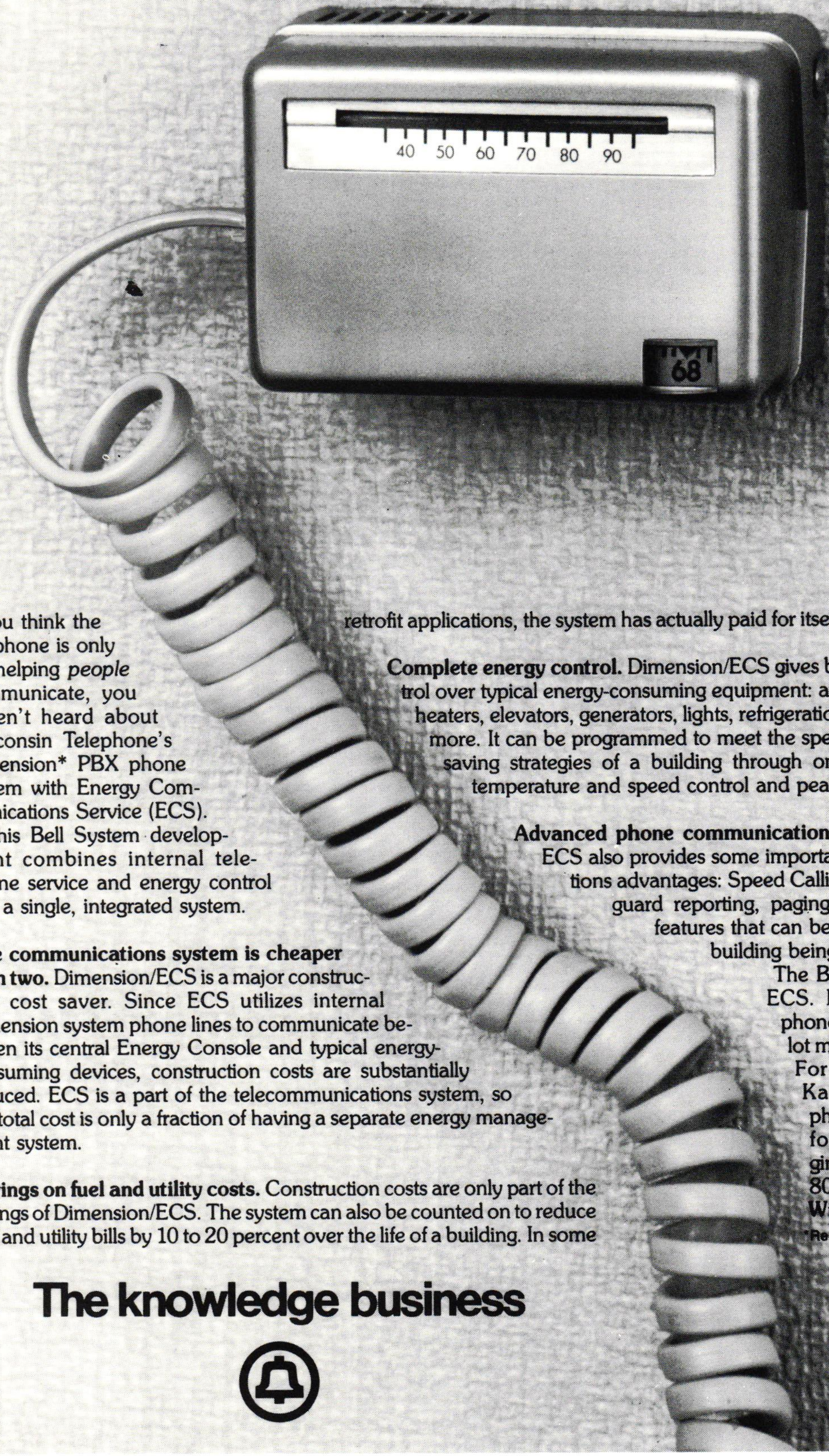

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This Bell System development combines internal telephone service and energy control into a single, integrated system.

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The knowledge business

Passive Solar Design In Wisconsin

By Michael Utzinger,
Asst. Professor

When passive solar heating systems are well integrated with architectural design, significant fossil fuel savings can result. However, improper design of a passive solar building can, as illustrated by the Jacobs II house, waste large quantities of energy. Appropriate passive solar design requires an understanding of the relationships between solar collection, heat storage and space heating loads of the building. This understanding is best approached by examining paths of heat transfer in and out of buildings. During winter buildings lose heat to the environment via skin conduction, conduction through the ground and air infiltration. These paths are typically summed yielding the total building heat loss. This heat loss must be replaced to maintain thermal comfort. Buildings gain heat from lights, people, equipment and solar radiation. Heat gains from lights, people and equipment are typically summed and referred to as internal heat gains. When total heat loss exceeds internal and solar heat gains, heat is supplied by the HVAC system.

An important measure of building space heating requirements is the annual space heating load. This is an estimate of heating energy (both solar and fossil fuel) which is required to provide a specified minimum thermal comfort level. Computation of the total annual load includes effects of skin conduction, infiltration, heat loss to the ground, thermostat settings, internal heat gains and the severity of the climate (as measured by degree days). Passive solar energy contribution to the annual space heating load is determined from the annual solar heating fraction, which is defined to be the fraction of annual space heating load met by solar energy. For a given location and passive solar collector, the annual solar heating fraction will be a function of three variables: the annual space heating load, passive solar collector area, and heat storage capacity of the building. These three variables are combined into two system parameters. The first system parameter is the collector-load ratio. The collector-load ratio is determined by dividing the collector area (in square feet) by the annual space heating load (in millions of BTU). For a particular passive solar building the collector-load ratio is the square footage of area of solar collector provided per million BTU of total annual heating load. As solar input of a given passive solar collector is strictly a function of collector area, the collector-load ratio can be imagined as the ratio of passive solar heat gain to annual space heating load.

The second system parameter is the storage-collector ratio. This ratio is determined by dividing the heat storage capacity of the building by the square footage of passive solar collector. The heat storage capacity of the building is measured in BTU per degree fahrenheit. The storage-collector ratio is a measure of the building's available heat storage capacity for each square foot of passive solar collector.

The relationship between the annual solar heating fraction and the two passive solar system parameters described above is illustrated in Figure 1. Values of collector-load ratio are indicated along the horizontal axis of the graph. The two curves represent high and low values of storage-collector ratio. For any unique combination of system parameters, the annual solar heating fraction is found on the vertical axis. There are two important characteristics of this graph. First, at low values of collector-load ratio the amount of solar energy available at night is small. Therefore, the value of storage-collector ratio has little effect on the solar heating fraction. At high values of collector-load ratio, there is a large amount

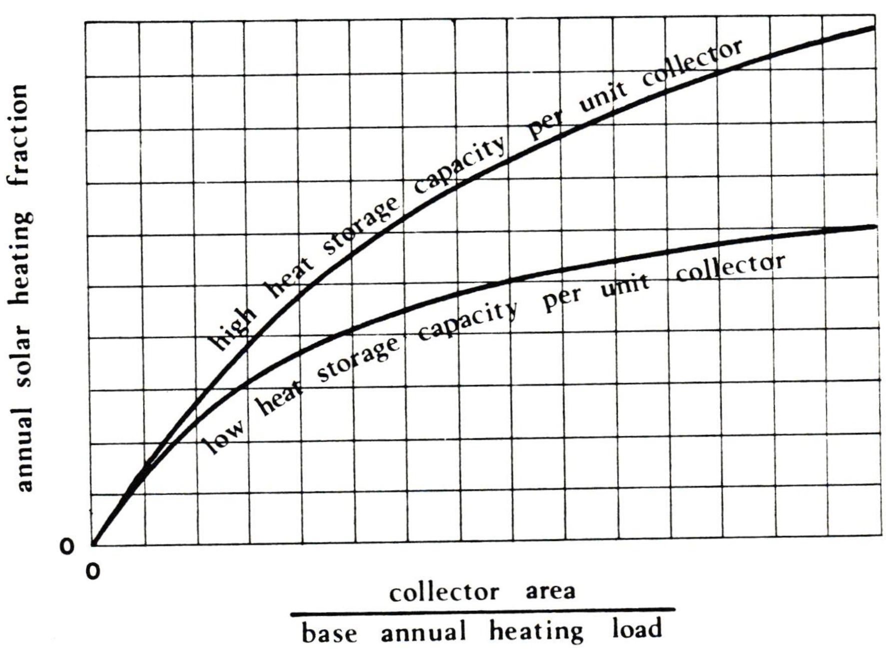

Figure 1. Typical passive system performance curve.

Wisconsin Direct Gain Chart No. 2

Double Pane Glazing; Night Insulation

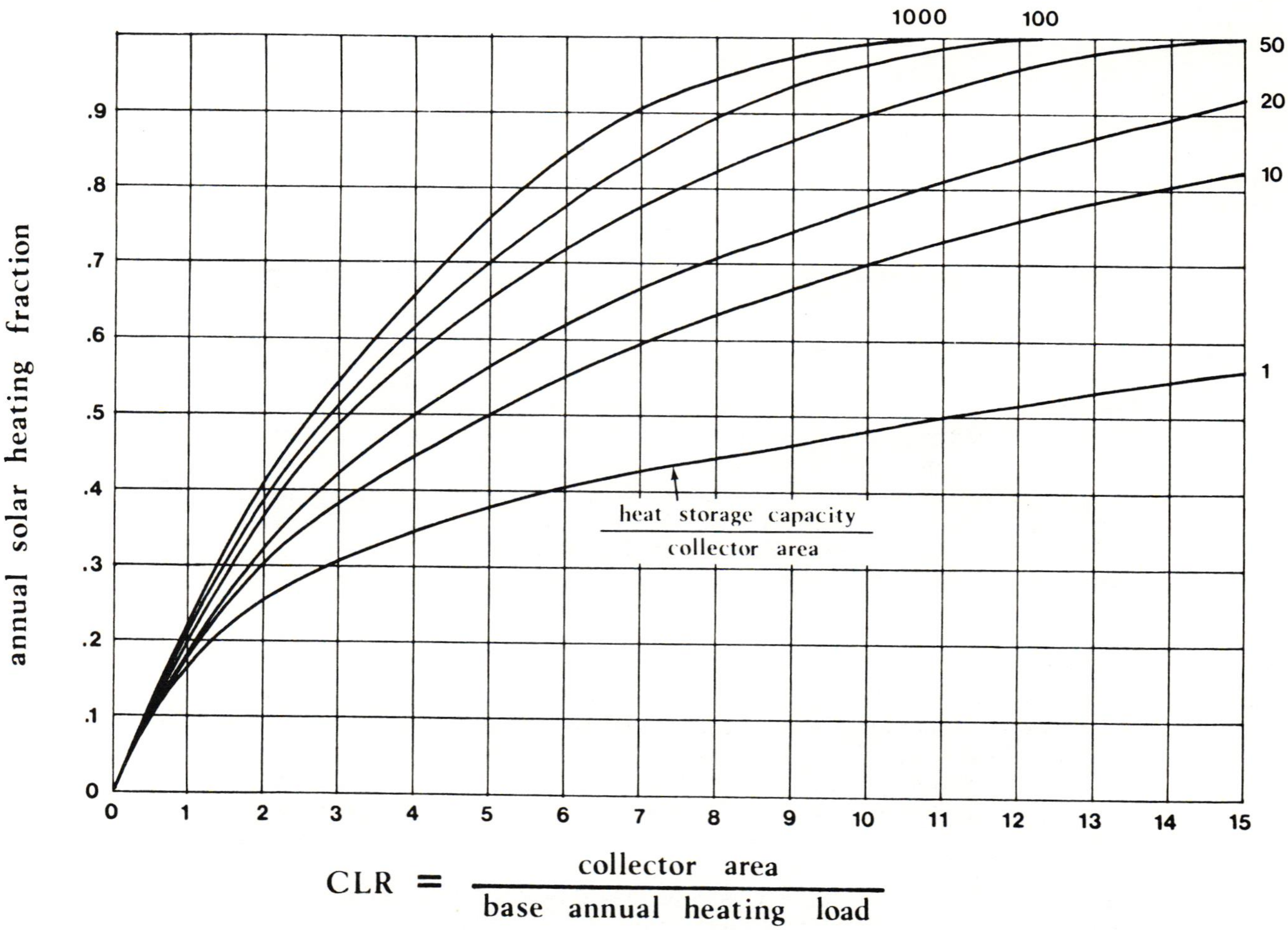

Figure 2. Typical passive solar design chart for Wisconsin.

of solar energy available for storage. Thus the storage-collector ratio has a significant effect on annual solar heating fraction. Second, at high collector-load ratio values daily solar gains exceed daily heat loss more often during the year. Therefore, additional collector area will not provide as much useful solar energy gain at high collector-load ratios compared with low collector-load ratios. This effects results in flatter curves at high collector-load ratios. The form of passive solar performance curve illustrated in Figure 1 is typical of any type of passive solar heating system.

General methods are available for estimation of the annual solar heating fraction. However, these methods require monthly estimates of absorbed solar radiation and space heating load. Either 16 hours of hand calculations or a computer is required for a single estimate of solar fraction. The School of Architecture received a grant from Wisconsin Concrete Products Association and the Concrete Masonry Industries to produce a simpler method of passive solar system evaluation. Research indicates that for a specific passive collector type (eg. 8 inch thick collector-storage wall with two glass covers), one chart plotting annual solar fraction as a function of collector-load ratio and storage-collector ratio will provide good performance estimates for any Wisconsin location across a range of thermostat settings and internal heat gain values. Passive solar design charts have been developed for six direct gain and nine collector-storage wall passive systems. A sample direct gain chart is illustrated in Figure 2. These charts will give performance estimates comparable to computerized methods yet require only one to two hours of calculation. Average difference of cost estimates of auxiliary space heating requirements between design charts and computerized methods over a range of locations and system configurations is $5.00 per year. The charts are very useful in a design iteration process where collector area and skin thermal quality are optimized. A 90 page handbook describing passive system evaluation is available for $5.00 from Wisconsin Concrete Products Associations, 512 Alta Loma Dr., Theinsville, Wisconsin. The booklet includes description of the chart method, worksheets, charts and and illustrated example.

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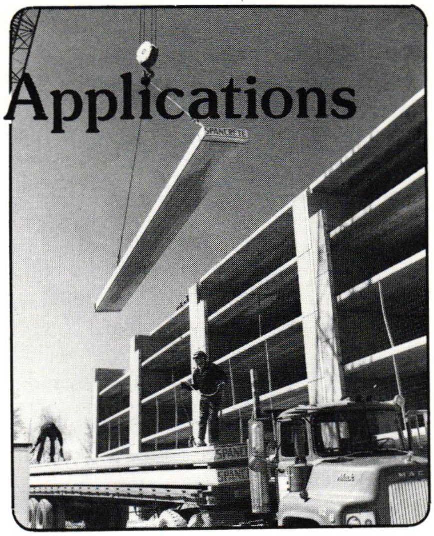
The Spancrete Project
Precast Concrete Passive Solar Applications



By Scott Johnston
Research Project Coordinator

In the spring of 1979 a program entitled Passive Solar and Hybrid Manufactured Buildings was created by the Department of Energy. The program was designed to accelerate the incorporation of passive solar techniques into the construction industry through the manufactured building market. Manufacturing firms ranging in size from small residential prefabricators to metal building manufacturers with national distribution networks have taken part in the program.

PROJECT DESCRIPTION

In response to the DOE initiative a proposal was developed by Spancrete Industries of Wisconsin in conjunction with the Energy and Buildings Research Institute of the University of Wisconsin-Milwaukee. A three phase project was outlined for the development, testing and ultimate marketing of precast concrete passive solar buildings. The thesis of the project was that concrete, being a massive building material, has the ability to store large quantities of thermal energy. By using precast concrete components for structural support and thermal storage, it was envisioned that significant energy savings might be achieved at minimal cost.

Achieving the inherent potential of precast passive solar systems, however, is not without its challenges. Foremost among the design issues that must be addressed is the diversity of the market for precast products. The market is comprised of mid and high-rise residential construction, warehouses, manufacturing buildings, schools and offices. Each of these building types represents a distinct pattern of energy demands. The variation found in space heating needs is and example. In a typical large office building daytime internal gains from occupants, lighting and equipment will exceed heat losses in all but the coldest winter months. Buildings in this category will obviously benefit from energy design strategies that are quite different from those employed in warehouses where internal gains are negligible.

Another aspect of the diverse market becomes apparent when details of precast manufacturing and erection techniques are being considered. The manner in which precast components are utilized varies from one building type to the next. High rise residences typically employ a bearing wall system. In office buildings, where flexibility in space planning is important, post and beam structures are more often used. The sale of individual components, such as double tees or hollow core plank, for use as floors or exterior walls of steel frame structures also represents a major market. Ideally, passive solar systems developed for the precast market should be designed to allow incorporation into the range of building and construction types encountered.

In addition to design considerations, a host of market factors will influence the success of a proposed passive solar building system. Certainly, all other factors being equal, if it can be demonstrated that the proposed building system will use less energy than alternative systems, it should enjoy an expanding market. Energy conservation is an integral part of the design of passive solar buildings. In a market sense, however, there is often a competitive relationship between passive solar strategies that emphasize increasing solar gains and the trend toward tighter construction practice and higher R-values that is already evident in the construction industry.

In the buildings where significant energy savings can be achieved through simple an inexpensive conservation techniques, the additional savings from a passive solar system may not appear to be an equally attractive investment. In this context it is important to view the market for passive solar buildings, not from the perspective of an energy conscious designer or passive solar enthusiast, but from the viewpoint of the real estate investor. Investors will continue to assess the value of an energy system on the basis of its potential return in relation to other possible investments. An investor who for tax reasons does not intend to retain ownership of a new commercial property for more than a few years will not be willing to invest heavily in an alternative energy system with a payoff in excess of that period.

As work on the Spancrete project progressed, two primary design objectives evolved from the market and manufacturing considerations noted above. First, it became clear that energy considerations alone would not override factors that have traditionally influenced the selection of precast construction over competing systems. We came to understand that the design of precast passive solar systems, therefore, should best be approached in terms of incremental change to existing manufacturing, erection and marketing practices. Secondly, it became clear that proposed designs would have to be sufficiently flexible to accommodate the

range of building types that currently comprise the market for precast products. In response to these guidelines, two strategies emerged for incorporating passive solar techniques and higher energy efficiency into precast concrete buildings: the use of precast collector-storage or Trombe walls and the use of hollow core floor systems for air supply and thermal storage.

COLLECTOR STORAGE WALLS DESIGNS

The Trombe wall concept is well known within the profession. Full scale Trombe walls have been studied in test rooms and in actual buildings under conditions of normal use. Based on testing and monitoring results, accurate simulations methods have been developed for predicting Trombe walls performance in varying climates. Earlier studies have indicated, however, that the effectiveness of Trombe walls is limited in northern climates, such as Wisconsin, where solar availability in winter months is low.

As part of this project, a total of six options were studied in an attempt to develop cost effective collector-storage walls designs for the Wisconsin climate. Options investigated were as follows.

- Installing movable night insulation on wall exteriors.
- Use of special glass low in iron content to increase solar transmittance.
- Use of "Heat Mirror" glazing especially designed to reduce heat loss to the exterior reflecting radiated surface heat back to the wall.
- Covering outer surfaces with a selective absorber material to reduce wall radiation loss.
- Casting plastic rods, containing phase change materials, into the wall to reduce wall heat loss by lowering the outer wall surface temperature.

In addition to these alternatives, a stagnant Trombe wall, designed without thermocirculation vents, was simulated to assess the value of thermocirculation. Annual solar performance was simulated for the basic wall (i.e., double glazing with a painted black outer surface) and for each of the options except the use of phase change materials. Simulations were performed using the TRNSYS computer program from the Solar Energy Laboratory of the University of Wisconsin-Madison. Incorporation of phase change rods was not simulated since a computer model for their behavior is not available.

The collector storage wall must be coupled to a building load in order to accurately simulate its performance and the auxiliary heating required. A warehouse building model served as the reference for heat loss and solar gain calculations. The assumed warehouse model was a 200' by 400' structure 25' in height with the long dimension running east/west. Since the ratio of solar gains to heating load for the warehouse model is quite low, simulations for this building type will tend to approximate maximum theoretical performance. The annual heating contribution for each wall configuration along with net wall costs and simple payback periods are given in table 1.

From these results it is clear that thermocirculation has an insignificant effect on collector storage wall performance in this climate. The four other options simulated do significantly increase wall output. They do not, however, greatly decrease the payback period when compared to the basic wall. The simple payback computations used here for system comparisons do not account for inflation,

Collector Storage Wall Options

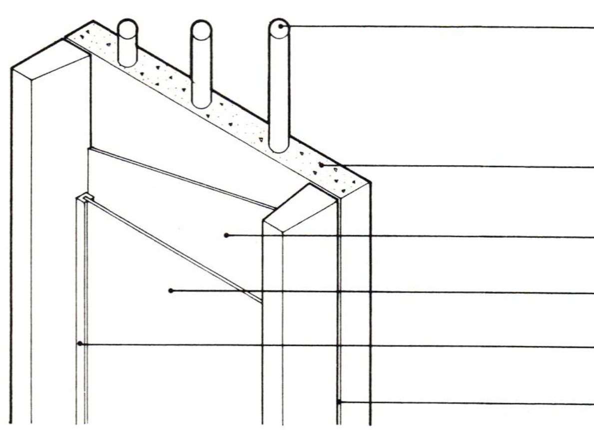
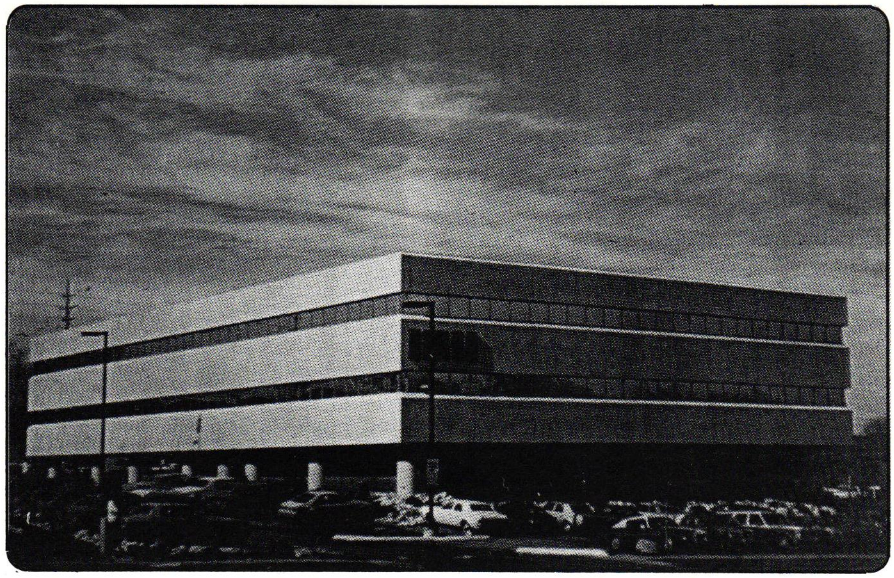


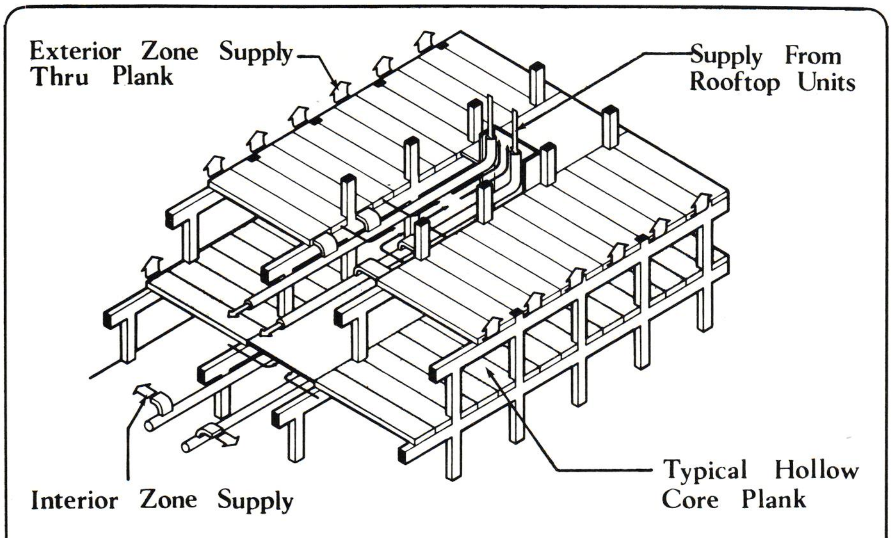
table 1
Wall Perfomance and Payback Period

DESIGN OPTION	WALL OUTPUT BTU/SQ FT/YR	PERFORMANCE INCREASE BTU/SQ FT/YR (%)	SIMPLE PAYBACK
Basic Wall	34,000	-	13.4 yrs.
Night Insulation	49,000	+15,000 (44%)	22.2 yrs.
Selective Absorber	57,000	+23,000 (68%)	12.1 yrs.
Low Iron Glazing	55,000	+21,000 (62%)	9.9 yrs.
Thermocirculation	35,000	+1,000 (3%)	-
Heat Mirror	56,000	+22,000 (65%)	-

fuel cost escalation, interest on loans or tax credits. When these factors are taken into account somewhat shorter payback periods could be expected for all options.

Phase change materials have the capacity to absorb large amounts of heat when changing from solid to liquid state. By incorporating phase change materials into the collector-storage wall, the peak outer wall surface temperature might be reduced as more energy is stored at the phase change temperature (81°F for the rods used). The result would be lower energy losses from the wall and increased collector performance. This thesis was tested by experiment. Phase change rods were cast into a concrete slab along with thermocouples to record the temperature profile through the wall. At peak temperatures (about 2:00 p.m. on a sunny day) test results indicated that the presence of phase change rods in the wall actually increased other surface temperatures. Since the higher temperatures observed would result in increased wall losses further study of this option was not undertaken.





MECHANICAL/STRUCTURAL SYSTEM INTEGRATION

1011 BUILDING HOLLOW CORE STUDY

A case study was conducted of a low-rise office building to analyze the costs and benefits of utilizing hollow core plank voids for air supply and direct radiant heating in a forced air mechanical system. The analysis is of the 1011 Office Building, recently constructed in Milwaukee, Wisconsin, using a hollow core floor system on a structural steel frame. Building use patterns and financial, design and construction considerations were determined as a base case against which revised construction costs and operating cost improvements could be measured.

The 1011 Building is a three story building measuring 100' by 170'. The interior layout is typical of speculative office buildings. A central corridor provides access to tenant spaces which vary from totally open plans to schemes where separate offices predominate.

The existing mechanical system is a variable air volume system for cooling only. Heating is provided with direct resistance perimeter units and some interior radiant panels.

In the case study, building structural and mechanical systems were redesigned to interconnect hollow core plank voids with the mechanical distribution system. Exposing the underside of hollow core plank also necessitated changes in framing and finish work. Thermal performance simulations and revised cost estimates were made to evaluate the redesigned building.

STRUCTURAL REDESIGN

A concrete post and beam system was substituted for the structural steel frame to enhance the marketability of the proposed building system and to reduce costs. The concrete columns and beams can be left exposed providing a finished appearance while maintaining the fire rating of the building. The use of all concrete structural components also simplifies erection procedures.

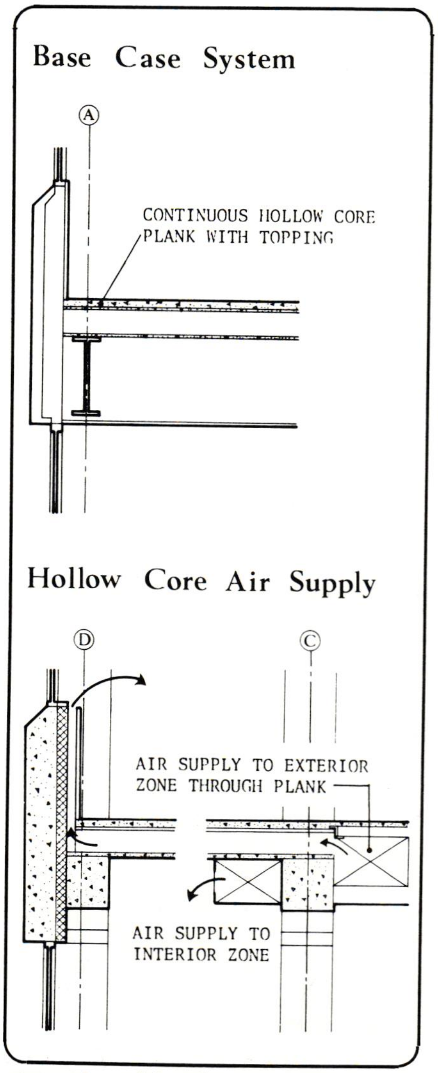
By eliminating the hung ceiling, a lower floor to floor height is possible. The 10'-8" dimension used in the redesigned structure means that the floor to ceiling height (approximately 10'

depending on plank depth) will actually increase. Structural costs are thus reduced while the potential for achieving higher levels of natural light within the spaces is enhanced. The elimination of the hung ceiling would, however, require that structural connections and random holes through the plank to accommodate mechanical and plumbing fixtures be more closely coordinated.

MECHANICAL SYSTEM REDESIGN

The heating, ventilating and air conditioning system used in the revised 1011 Building is a medium velocity variable volume system using ultralight Spancrete plank as part of the air distribution system.

For south and north exposures, supply air is ducted through the plank voids to the perimeter terminal VAV units. The core section is served with conventional ductwork. All terminal units are under the control of space thermostats as dictated by tenant layouts.



CONCLUSIONS

Several findings have evolved from the work on this case study.

1) Integrated precast concrete plank and HVAC systems do offer energy saving possibilities. The value of energy savings will be a function of climate and method of system integration. The results of thermal simulations performed indicate that both exposing the plank to the space and ventilating the plank at night via air circulation through the voids do lead to significant energy savings. However, our results also indicate that improved performance may be more directly attributable to exposure of thermal mass to the space than to actual air flow through the voids.

2) Mechanical system controls are important and could be crucial to the effectiveness of the ducted hollow core system. Energy savings result primarily from shifting or flattening out energy demand curves over the course of a day's operation, through the efficient use of the buildings structural mass. Control strategies, such as temperature setbacks, dead band thermostats, and preheating and precooling the hollow core plank in anticipation of space conditioning requirements, will play a major role in the effectiveness of this system.

3) The revised total construction cost for the 1011 Building using Spancrete hollow core plank for ducting was actually lower than the cost of the base case building. Revisions made to increase thermal interaction between the plank and the occupied spaces also provided several opportunities for reducing costs. Cost savings are achieved primarily through lower floor to floor heights and the elimination of the suspended ceiling which in turn is made possible by supplying air through the plank rather than through separate ductwork.

This latter finding is of particular importance to the market for this system in speculative commercial properties. Often the developer's primary concern is the initial cost of the building and not operating costs which can be passed on to the tenant or future owner. The fact that many commercial buildings do employ electric resistance heating systems is in itself a function of first cost economics. In buildings like the 1011 Building, for example, the cost of substituting a conventional forced air mechanical system for baseboard resistance heating would have been prohibitively expensive.

Energy savings for the hollow core integrated mechanical systems will depend on climate and on building system design. The positive thermal benefits observed and the reduced first cost of the redesigned 1011 Building fostered further research in this area.

As a result of work begun in the Spancrete Project, a major industry wide effort is now being planned for laboratory testing of air flow in hollow core plank. Test modules will simulate a range of possible building conditions. By varying plank configurations, air flow rates and temperatures, the dynamics of heat transfer in planks can be modeled. Performance data from these tests will ultimately be used to develop hollow core air supply and radiant heating design methods. For the first time mechanical engineers will have the tools required to accurately determine comfort conditions and energy savings in buildings utilizing this system. In the process, a design concept that for years has been a novelty in the industry will finally gain the stature of being common practice.

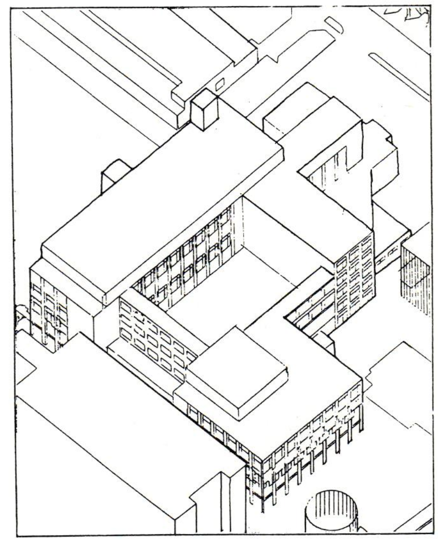
Solar Graphics Research

By Anthony Schnarsky
Associate Professor

Can a computer program assist a designer to develop an energy conscious building that also has architectural merit? This is the central question for a small energy research group within the UWM School of Architecture and Urban Planning. The "Solar Graphics" group is conducting research current with energy studies being undertaken in many parts of the country. In order to better understand the scope of this effort the reader is directed to the April, 1982 issue of **Progressive Architecture** for an excellent survey of state-of-the-art solar research. It will be seen that the performance goals for research at UWM match many of the issues discussed in this energy focussed magazine.

Three factors make the "Solar Graphics" research relevant. First, an accurate, affordable design method tool is needed that can account for buildings on sites with crowded contextual settings. Most of the existing powerful energy analysis programs cannot effectively account for solar access interference caused by surrounding buildings and vegetation as part of a general method. Second, a graphic tool requires development which will address the intuitive and visual needs of the designer. One of our hypotheses is that the designer will be more apt to use a tool that responds with pictures of the design as well as graphs of the design's energy performance. A related contention is that users should not have to input huge amounts of numbers, nor have to sort through vast amounts of quantitative output. Lastly, our goal is to develop a tool that encourages the designer to evaluate energy aspects earlier in the design process. Taken together these goals lead to forming a graphic tool that will facilitate integration of energy and design throughout all building development phases in a timely and affordable fashion.

UWM's "Solar Graphics" research began when a graduate student who had just completed an energy course, and currently enrolled in a computer graphics course asked the impertinent question: "Can you put these two programs together?" The two programs referred to are called F-CHART and SHOW. F-CHART, developed at UW-Madison Solar Energy Laboratory, is capable of accurate energy analysis for most conditions in a building. F-CHART is a design methods program because it statistically condenses solar and weather data into twelve representative days of the year. More accurate programs exist for energy analysis which give hour by hour simulation for each day of the entire year. These energy simulation programs are very expensive to use and they tend to defer exploration of energy issues until late in the design process. F-CHART encourages the users to examine many variations earlier because its input allows easy modification of the design parameters and because it is rapid and inexpensive to run. However, F-CHART cannot account for surrounding context and it is not graphic in its output. The second program, SHOW, is completely graphic in attitude. SHOW can generate a picture representing most building and natural forms in the environment. The projections produced by SHOW can be perspectives or orthogonals taken from any vantage point that the user chooses. More compelling still, from any energy standpoint, is a visualisation of the proposed design called a "sun shot" or "sun view". The user can specify any location and orientation in the northern hemisphere at any time of day and get a view of the



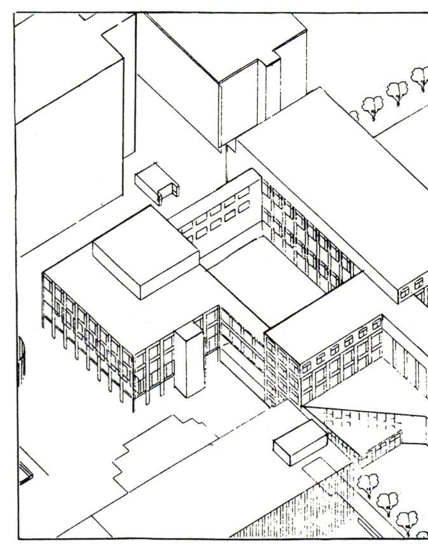


Figure 1: Two Sun Views of a Complex Building with Surrounding Context. These are computer generated isometrics called "sun shots". These projections show the user what surfaces and openings are exposed to the sun. The program can compute the exact area exposed at any given instant for any surface. This ability to compute instantaneous area is the basis for quantifying passive solar gains hour by hour over statistically typical days in the year. The program's general graphic methodology can account for many shapes, orientations and surrounding conditions.

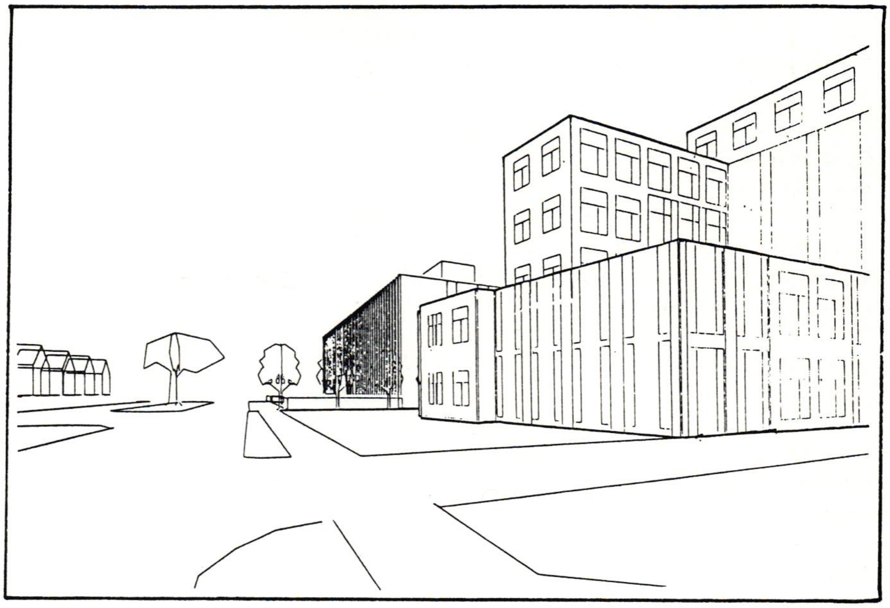


Figure 2: Perspective View from Street. Not only is the designer concerned with energy issues, but at the same time must be concerned with architectural issues. Here the designer is viewing the same design as in Figure 1 from the vantage of up the street.

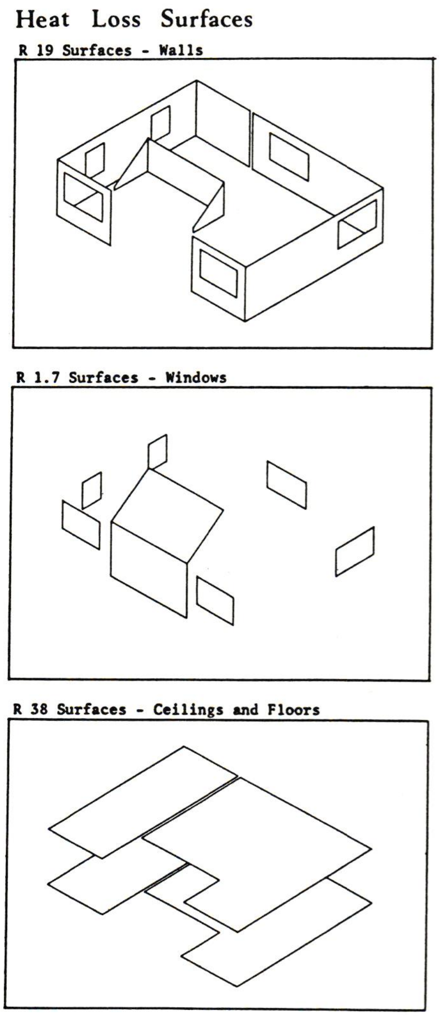


Figure 3: Internal Representation of Energy Envelope. In the previous figures the output is visual. This figure indicates the internal model of the surfaces of the building from the standpoint of the energy analysis. The shape, area, and orientation of each surface in the envelope is derived from the same input data as the graphic output. Before this time F-CHART users had to compute these properties and input them. Now the properties are computed automatically. This ability to get visual as well as quantitative information from a single physical description is a powerful incentive to a busy professional.

design in its context from the vantage of the sun. Shadows are not seen in these projections since the building is always perceived as if viewed by the sun.

F-CHART with its powerful simulation capability provides the user with quantitative and technical predictions about the energy consumption related to design decisions. SHOW with its generality and visual simulation gives the user qualitative insights about design decisions. The impertinent student asked a good question regarding the needs of the professional in this area of energy and design integration.

Early in the research studies of existing programs found three significant deficiencies that would deter general designers from using computerized energy design methods. Research that would successfully overcome these deficiencies is current with state-of-the-art research. The first characteristic found in existing programs was a tendency to limit the range of design elements especially with respect to their type and orientation. For instance, only certain types of shading devices could be modelled and only for principal orientations like East, West, and South. The second limiting assumption in many existing programs was that the surrounding building forms and vegetation could not be accounted for. Most designs in reality do not occur on absolute flat sites, but rather on crowded conditions where solar access is often blocked. The third general deficiency found was the great tedium and specialized skill required to model and input the design into a computer energy analysis program. Related to this was the problem that for all that input only singular results came back usually in the form of a lot of numbers that had to be analyzed by the user.

The two programs taken together produce technical capabilities that had not been previously examined for a design methods program. Now most architectural forms and energy systems and components can be modelled with a general graphic method. The effect of the surrounding context on solar access could be accurately predicted for any moment of the day. The designer now has less to pre-compute and input. For the effort of modelling the form once the designer receives multiple levels of output both in a visual form and in graphs representing the energy analysis.

The integration of the two older programs, F-CHART and SHOW into a new one lead to a new energy design method program called SOLAR. This name refers to the program's extensive ability to account for solar energy gains and losses as well as other energy flows.

In addition to good technical versatility in energy analysis the research group has outlined a set of performance goals which are important to the tools useability given the other needs of the general designer. Without these characteristics the tool with all of its power will not be accepted by the practicing professional. Below are listed all of SOLAR's important performance goals for professional useability:

USEABLE AT ALL DESIGN PHASES The program can be used at most stages of the design process from schematic to contract documents. At early phases the program needs only rough approximate volumetric information and produces accordingly approximate analyses. As the design approaches final level the energy analysis asks for more detailed descriptions and produces more accurate analyses.

GRAPHIC METHOD ACCOUNTS FOR CONTEXT AND GREATER RANGE OF DESIGNS The graphic method enables an already sophisticated energy analysis method to account for surrounding conditions and more complex designs.

ENCOURAGE INTERACTIVE DESIGN The program encourages the designer to try variations in form, orientation, and properties of the envelope. The program is sensitive enough to account for detailed changes in the design. In effect the designer can try many variations and learn about this particular design first hand.

INCORPORATE GOOD ENERGY DESIGN STANDARDS Especially during the schematic stage the program has many parameters pre-set. This is done in order to shorten input time, and to incorporate good energy design strategies already developed in an office. The program has a very easy technique allowing the user to review and change these parameters at any time quite easily.

PROMPTED INPUT AND WORD COMMAND STRUCTURE The program prompts the user, often drawing an illustrative figure to explain what needs to be input. The graphic nature of the program also helps to catch modelling errors since the design can be viewed by the user. A word command structure gives the user easy control over the flow of the program. Some example commands follow:
SHOW WALL 6
CHANGE ROOF 3 TO U = .035
HELP

EFFECTIVE OUTPUT The output for the energy analysis begins with an executive summary. Realize that the data being generated internally comprises of what happens to all of the energy components in a building for twenty-four hours of twelve statistically representative days in the year. Initially, the designer wants only to see if the combination of decisions for a particular design trial made any improvements over previous trials. The second concern is what contribution do major groups of components have to the total energy consumption. The executive summary comprises of a scaled circle, a pie graph within the circle showing percent of contribution, and the total energy consumption per square foot. By this means the user can keep a history of various trials. For any trial more detailed lists of energy consumption by parts may be requested from the program.

THE OUTPUT IS USEFUL FOR OTHER DESIGN TASKS The program produces data that is useful to task such as cost estimation, area take-offs, structures, mechanical, lighting and electrical.

When fully developed, SOLAR will be a very useful design tool that will give the user both visual and quantitative information to improve the building design. The program is particularly unique in the emphasis on integrating an important technical issue, energy, with other more general architectural aspirations. This program's goals balance the computer's rigor and numerical capacity with the intuitive capacity of the designer in these most difficult design conditions.

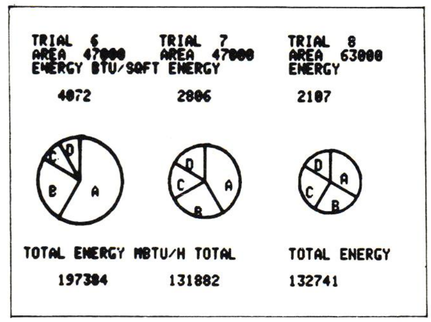


Figure 4: Executive Summary of Energy Analysis. The figure above shows the last three trials attempted by the designer. Very quickly the user can see which design uses the least energy per square foot (the smallest circle). In addition, the circles indicate pie graphs showing the contribution of each major group of energy use in the building. For instance, A could be the roof, B all of the walls, C all of the openings, and D all of the miscellaneous. A typical energy design goal is to uniformly balance these part useages.

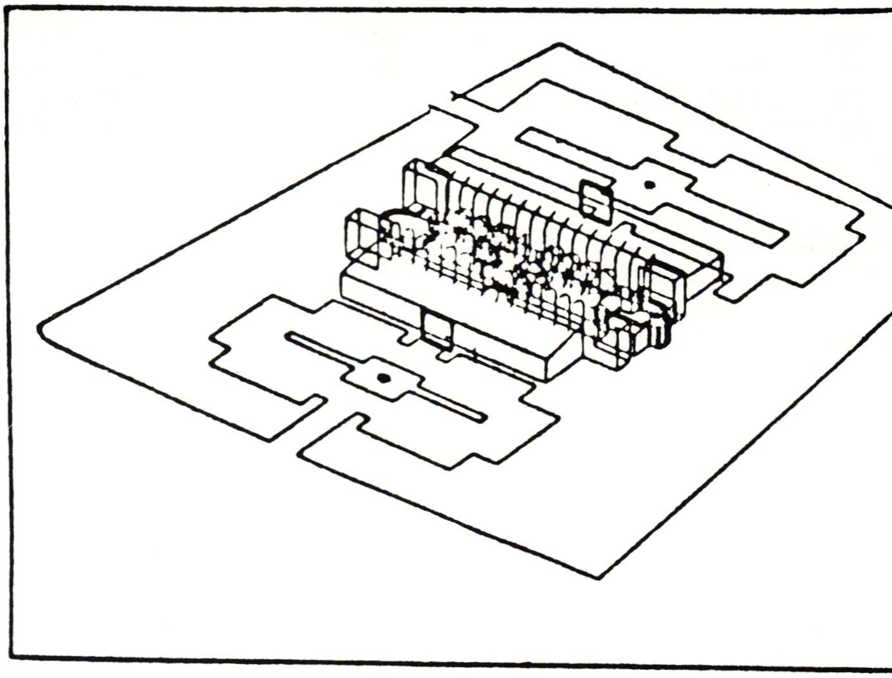


Figure 5: Sun View of an Office Building with a Solar Courtyard. This is a "sun shot" of the courtyard during a spring or fall season. The question posed by this view is the amount of sun penetration into the courtyard during seasons when micro-climate is important in extending useability of outdoor spaces.

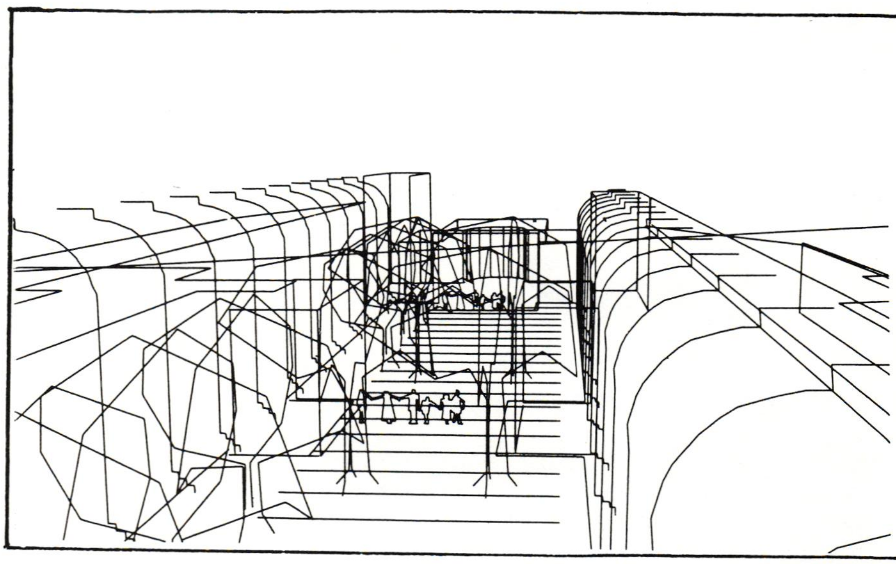
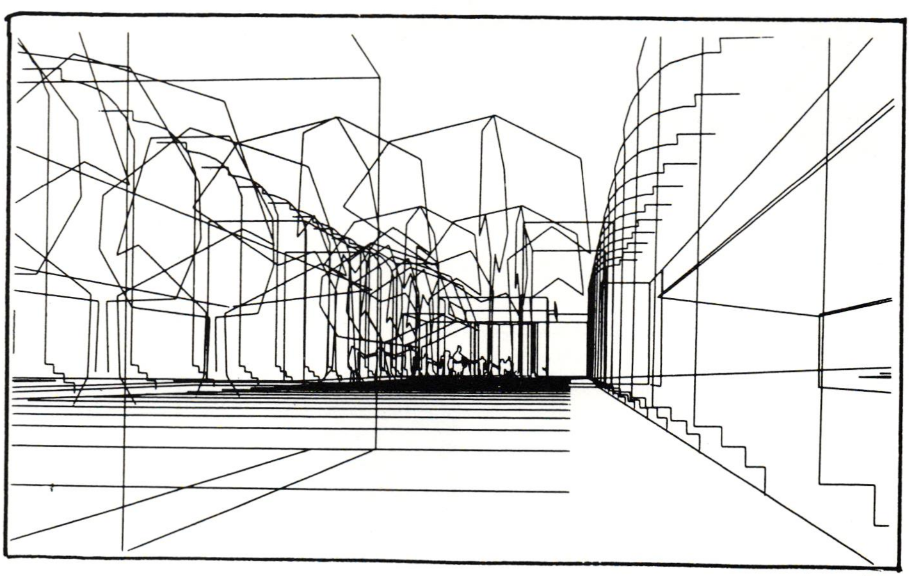


Figure 6: Perspectives of Office Courtyard. This is a study of the same building as in Figure 5. These views show the designer checking the scale and proportion of the design decisions.



ACKNOWLEDGEMENTS: First, a thank you to the impertinent student who asked if the two programs could be merged. Scott Johnston. Second to Michael Utzinger, a true energy researcher and concerned architectural critic. And last, to the student designers who used the early tools, Jordon O'Connor and Chris Rute.

WSA

Fall Design Workshop

September 17, 1982

La Crosse

Design

Interpretations:

Form

Function

Fantasy

WSA

SOCIETY NEWS

ANONYMOUS LETTER

A recent issue of the WISCONSIN ARCHITECT published the results of a salary survey conducted by the WSA. If you haven't seen that issue of the magazine (May, 1982) read the numbers . . . and weep.

If the numbers don't shock you as being on the low side for professional services you've been hiding. It's not uncommon for a lawyer to start work in Wisconsin at $18,000.00 per year and to be making $60,000.00 within the first 10 years of practice. Or how about accountants? CPA's in Wisconsin can make $20,000.00 in their first year and will probably make $50,000.00 by the time they have been in practice 10 years. Or how about your favorite consulting engineer? They can start at $19,000.00 per year, can be making $35,000.00 within 10 years of graduating from school and can make over $50,000.00 once they become a full partner in their firm. These aren't Harvard graduates working in New York City . . . these are your friends, neighbors, and high school classmates in Wisconsin.

What's the problem?

Fees.

You've got a choice. Live poor, marry wealthy, or charge fees that provide adequate compensation for the professional service.

Think about this disparity next time you sit down to negotiate fees.

Editor's note – This letter was anonymously delivered to the WSA's doorstep in the dead of night under a full moon. Your comments on matters of significance to the profession (anonymous or otherwise) are solicited for publication.

FALL WORKSHOP PLANNED IN LA CROSSE

MOORE, CARLHIAN, WILLIAMS. What do these three architects have in common? They're all coming to La Crosse for the 1982 WSA/AIA Fall Design Workshop.

This year's theme, entitled "DESIGN INTERPRETATIONS: FORM, FUNCTION, FANTASY" will be brought to life by 3 nationall-known architects - Charles Moore, Jean Paul Carlhian and A. Richard Williams.

The conference, to be held on Friday, September 17, 1982 at the La Crosse Center, will feature the 3 speakers in an all-day session, starting at 10:30 a.m. and concluding with a panel forum in the afternoon.

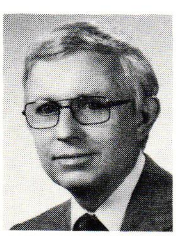
Registration materials on the design conference will be coming soon. To illustrate the "Form, Function, Fantasy" theme, registrants from each firm will be asked to submit 3 slides for "interpretation" during the panel discussion.

For more information, contact the WSA office. Registration will be limited to 200 people.

WAF REPORT

Emma Macari

Richard Blake



Robert Kluth

The Wisconsin Architects Foundation (WAF) was created in 1954 for the purpose of supporting architectural education. This support is provided through scholarships, lecturers, grants and special programs.

Over the years the WAF dispersed an excess of $70,000 in funds, and currently has invested funds in excess of $55,000. The WAF currently disperses approximately $8,000 in grants and scholarships on an annual basis.

Membership in the WAF is open to any individual or entity that makes an annual contribution or donation to the WAF. The WAF is operated by a nine person Board of Directors. The current Board is comprised of seven architects and two public members who meet three to four times a year for purposes of administering the WAF funds and actively soliciting additional contributions to the WAF. Three new members have recently been elected to the WAF Board of Trustees. They are Emma Macari, AIA, of Madison; Richard Blake, FAIA, of Milwaukee and Robert Kluth, Senior Vice President and The Radford Company, Oshkosh, Wisconsin and Division Manager of Radford's La Crosse office. The Radford Company is a wholesale distributor of millwork including Andersen Windows, Morgan Woodwork and prehung wood and steel door units. The Radford Company has been in business for 112 years and distributes throughout a six state area with offices in Oshkosh, La Crosse, Madiosn, Duluth, Fargo, Bismark, and Omaha. The second public member of the Wisconsin Architects Foundation is Paul Bronson, Chairman of the Board of Best Block Company.

Current officers of the WAF are Leonard Reinke, FAIA, President; Paul Bronson, Vice President and John Somerville, AIA, Secretary/ Treasurer.

ARCHITECTS SALES TAX LIABILITY

Effective May 1, 1982 Wisconsin imposed a 5% sales tax on various types of landscaping charges, including "landscape planning and counselling." An architect or any individual who provides services pertaining to the design or planning of landscaping must collect a 5% sales tax. If the designer or planner charges the customer an amount for the total plan of constructing a building, driveway, etc., only the portion of the total charge that pertains to landscape planning is subject to sales tax. For more information contact Eric at the WSA office or contact the Wisconsin Department of Revenue (608)266-3873.

WSA MEMBERHSIP REPORT

The WSA now has close to 800 members. This figure represents a substantial increase from the 525 members three years ago.

Research indicates that more than 50% of the time the immediate impetus for joining the WSA is provided by a member asking or urging a friend or associate to join. This request is usually made by someone who the non-member trusts or respects. Growth in the WSA membership is directly related to maintenance and growth of the quality of programming available to WSA members. Urge a friend or associate to join. If you need a membership brochure, an application, or background information, contact the WSA office. If you or a non-member feel that the WSA should be taking a new or revised direction in terms of its programming, legislative efforts, publications, etc., feel free to speak up and participate.

Take the initiative. Ask a non-member to join.
WSA membership dues have not been raised in seven years.
Promote architecture by promoting membership in the WSA.

LAWSON ELECTED TO AIA BOARD OF DIRECTORS

David E. Lawson, AIA, of Madison has been elected to serve as a member of the AIA Board of Directors for a three year term commencing January 1, 1983. Lawson was elected by representatives from the AIA's North Central Region, composed of Wisconsin, Minnesota, North Dakota, and South Dakota. There are 36 members of the AIA Board of Directors, representing the over 36,000 members of the AIA. Leroy Bean, AIA, the retiring representative of the North Central Region to the AIA Board of Directors was re-elected to a one year term as a Vice President of AIA.

AIA LAPEL PINS

The WSA office has discovered the source of AIA lapel pins. You can put the bird on the lapel of your favorite suit (or anywhere else) by calling Karen or Sandra at the WSA office and placing an order. These pins are only available to WSA/AIA members at a cost of $5.00.

Promote architecture and AIA by wearing your pin.